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Inappropriate tourist behavior in protected areas can lead to wildlife road-kills

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Tourism in protected areas is increasingly important to the economy of environmentally vulnerable countries (Balmford *et al*., 2015). However, when pursuing sustainable tourism in protected areas, balancing the benefits of tourism with its associated impacts, including the increasing access (mainly through roads) to the last wilderness refuges, remains a challenge (Samia *et al*., 2017). Africa is home to a number of iconic wildlife sanctuaries visited annually by millions of tourists (Balmford *et al*., 2015). Current projections of ecotourism development suggest a significant increase in the road network - both paved and unpaved roads - in this region (Meijer *et al*., 2018), as well as other improvements to the infrastructure network, within and between protected areas.

In protected areas with limited freedom for people to walk or be outside vehicles, as in those African parks where the main attraction are self-driven safaris, river crossings are some of the main places where people can interact with and come close to wildlife, such as animals that come to drink from the river, as well as waterfowl and some iconic residents such as crocodiles (*Crocodylus niloticus*) and hippos (*Hippopotamus amphibius*). In one of these river crossings in the Kruger National Park, South Africa, we observed dozens of serrated hinged terrapins (*Pelusios sinuatus*) approaching the vehicle immediately after we stopped our car to spot wildlife (Fig. 1a-b; see video in Supplementary Material).

The terrapin behaviour we observed suggests that tourists feed these animals when stopping at this particular river crossing. One of the greatest negative consequences of the massive increase in tourism in protected areas is the habituation of wildlife to humans, implying the loss of their perception of these tourists as potential

predators (Tablado & D'Amico, 2017). If confirmed, feeding by tourists could dramatically increase the risk of wildlife road-kill, one of the most important negative impacts of the car-dependent tourism (Tablado & D'Amico, 2017). The attraction behaviour we saw at the river crossing could underlie the high rates of road-kill suffered by freshwater terrapins in African studies, which appear to be higher than those of their terrestrial relatives (Collinson *et al*., 2015; Kioko *et al*., 2015).

To our knowledge, this is the first documented example of a new threat to wildlife inhabiting protected areas, i.e., the increase in road-kill risk due to inappropriate tourist behaviour, as in this case, intentionally feeding wildlife at river crossings. As a first step, we suggest the installation of signs/signals at the entrance to the fords reminding tourists of the prohibition of feeding all fauna, similar to those that already exist in the rest camps targeting primates (Fig. 1c). However, this is likely a widespread and growing problem in protected areas and should be taken seriously by wildlife managers. One could speculate that those animals that people do not consider dangerous (small, herbivorous species) would be most affected, however we argue that the first thing to do would be to study how generalizable the case observed here is. Still, research on tourist-feeding attitudes and its consequences for road-kill risk is lacking. This gap in our knowledge prevents the implementation of effective mitigation measures, including guidance on best practice to educate tourists and dissuade wildlife from approaching vehicles in search for food.

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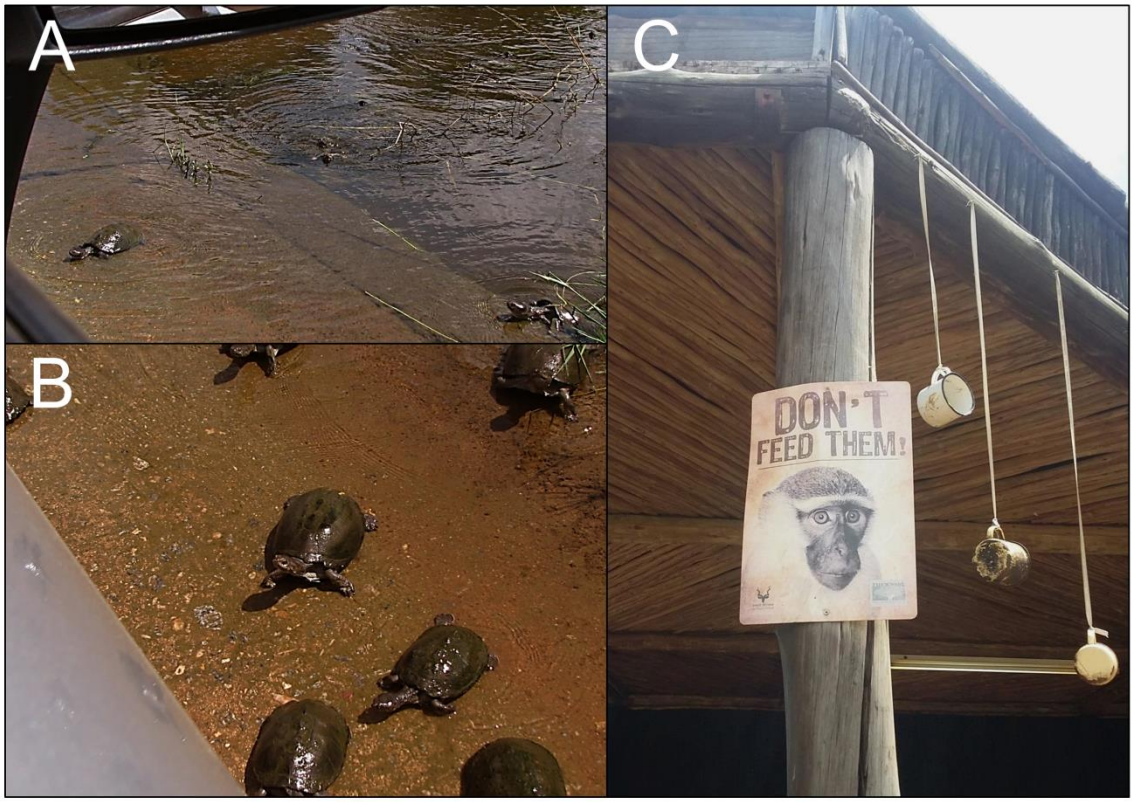
97 **Fig. 1.** Freshwater terrapins approaching the car when stopped to spot wildlife (**a**-**b**).
98 Example of a sign reminding about the prohibition of feeding the fauna (**c**). In the case
99 of ford entrances, the monkey could be substituted by an aquatic species.



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